Impact of Regulatory Stress Tests on Banking Sectors in the EU and US[1]

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Abstract

Simulating the conditions of economic recession and estimating its impact on bank risks and performance can help banks to prepare its portfolios for negative consequences of financial shocks. In this context regulators worldwide conducted series of system wide stress tests with the motivation to assess the financial institution health. The primary goal of this article is to analyze the significance of regulatory system wide stress tests impact on individual bank institutions and the banking sector as a whole. The analysis was performed in two phases. At first, to identify short term impact, we analyzed changes in the bank share price volatility, during the period of stress test results announcement. In the second phase, we constructed a linear autoregressive model (AR2) with structural dummy variables representing the stress test results announcement shocks. Consequently, we assessed the shock variables' significance and its direction of influence on bank shares in long run. The analysis was performed in two different stress testing environments carried out by the European Banking Authority (EBA) and the US Federal Reserve System (FED), and covered two system wide stress tests within the period of 2012 – 2017. We see the main contribution of the paper in assessment of regulatory stress test impact on the EU and US banking sector. Performed analysis was primarily based on market sensitivity to external shocks assuming market efficiency to enable the evaluation of banking institutions' health and the sustainability of their businesses. The output of the analysis indicates, that the release of system wide stress test results had a significant impact on banking sector performance, especially in the US market.

Keywords: risk management, stress testing, volatility, EBA, FED
JEL classification: G31, E58

1. Introduction

As a reaction on financial crisis regulators worldwide conducted series of system wide stress tests with the goal to assess the financial institution health and its resilience to withstand possible disturbances in financial markets during economic recession. The primary goal of this article is to analyze the significance of regulatory system wide stress tests impact on individual bank institutions and banking sector itself. The analysis was done in two steps. Firstly, we analyzed changes in bank share price volatility around stress test results announcements. Secondly, we constructed a linear autoregressive model AR (2) with dummy variables representing stress test results announcements, where we assess significance and direction of dummy variable coefficients. The analysis is done on the sample of EU and US bank houses covering two system wide stress tests within the 2012 – 2017 period. The sample consists of 24 banks with two types

[1] *This paper is an outcome of research project VEGA 1/0946/17 "Credit Cycle and its determinants in countries of Central and Eastern Europe."*

of institutions. On the one hand, there are banks which failed to pass minimal 8% Core Equity Tier 1 (CET1) capital requirements in severe stress test scenario. On the other hand, there are benchmark institutions with the strong and resilient capital structure which CET1 capital adequacy in severe scenario remained over 8 % threshold. We assumed that institutions who failed stress test, would experience significant deterioration of marked value represented by share price drop in period after stress test results announcement.

2. Theoretical Framework and Stress Test Environment Definition

According to Mishina et al. (2006) the ultimate objective of stress tests is to assess the performance of the financial system under abnormal operating conditions. The financial system, however, is a complex entity consisting of a wide range of financial institutions, financial markets, and payments and settlement systems, and it is not easily amenable to aggregate analysis. In practice, the analysis of financial system stability focuses on individual components, most often the financial institutions, to arrive at an overall assessment of the financial system. Moreover Virolainen (2004) points out that stress tests are generally used to complement financial institutions' internal models, such as value-at-risk (VaR). Standard VaR models have been found to be of limited use in measuring financial institutions' exposures to extreme market events, i.e. events that occur too rarely to be captured by statistical models, which are normally based on relatively short periods of historical data. In addition to applying stress tests to the portfolios of individual institutions at the micro level, stress testing plays an important role in the macro-prudential analysis of public authorities. The role of macro-prudential or financial stability, analysis has gained in importance in recent years, both among central banks, regulatory authorities and international agencies.

Decisions made by regulatory authorities or central banks, may have a significant and long lasting impact on the entire banking sector. Borio et al. (2015) investigate the effects of regulatory monetary policy thought bank profitability, using data of 109 large international banks for the period 1995–2012. Author points on the fact, that there exists a certain relationship between the interest rate structure and the bank profitability (return on assets). The paper suggests that, over time, unusually low interest rates and an unusually flat term structure erode bank profitability. Altunbasa et al. (2014) investigate the effect of relatively loose monetary policy on bank risk through a large panel regression including quarterly information from listed banks operating in the European Union and United States. Article suggest that relatively low levels of interest rates over an extended period of time contributed to an increase in bank risk. This result holds for a wide range of measures of risk, as well as macroeconomic and institutional controls including the intensity of supervision, securitization activity, and bank competition. The results suggest that monetary policy is not neutral from bank financial stability perspective.

In volatility analysis, we focused on the impact of stress test results announcement on the bank share prices volatility, which represents market participant's opinion of bank financial health and condition. In similar and more general context, Bomfim (2003) examines regulatory pre-announcement and news effects on the stock market in the context of public disclosure of monetary policy decisions. Author conclusions suggest that on days preceding regularly scheduled policy announcements the stock market tends to be relatively quiet, with conditional

volatility abnormally low. The paper also analysis how the actual interest rate decisions of policy makers affect the stock market volatility. The element of surprise in such decisions tends to boost stock market volatility significantly in the short run, and positive surprises, higher-than-expected values of the target federal funds rate tend to have a larger effect on volatility than negative surprises. Very interesting analysis concerning announcement effects can be found in Li et al. (2016) paper, where the authors study the differences in the announcement effects of seasoned equity offerings (SEOs) of commercial banks and non-bank companies. Article explores the influence of bank regulation and the financial crisis using propensity score matching-based (difference-in-difference) analysis. Abnormal stock returns on SEO announcements for US commercial banks are significantly higher than those of non-bank companies, which suggests, that bank regulations reduce the likelihood that bank SEOs signal overpriced equity. Wang and More (2007) investigate sudden changes in volatility in the stock markets of new EU members using GARCH models to detect the sudden change in variance of returns and the length of this variance shift. A sudden change in volatility seems to arise from the evolution of emerging stock markets, exchange rate policy changes and financial crises. According to Bacchiocchi and Fanelli (2014) a growing line of research makes use of structural changes and different volatility regimes found in the data in a constructive manner to improve the identification of structural parameters in the Structural Vector Autoregressions (SVARs). Authors approach generalizes the existing literature on 'identification through changes in volatility' to a broader framework and their empirical illustration focuses on a small monetary policy SVAR model of the U.S. economy which suggests that monetary policy has become more effective at stabilizing the economy since the 1980s.

2.1. US FED and EBA Stress Test Environment Definition

The Federal Reserve (2015, 2016) expects large, complex bank holding companies to have sufficient capital to continue lending to support real economic activity while meeting their financial obligations, even under stressful economic conditions. Stress testing is the tool that helps bank supervisors to measure whether banks have enough capital to support its operations throughout periods of stress. In 2015 the FED stress test was carried on a sample of 31 banks, while in 2016 it was 33 banks. The models are based on hypothetical, stressful macroeconomic and financial market scenarios developed by the Federal Reserve. The severely adverse scenario features a deep recession in the United States, Europe, and Japan, significant declines in asset prices and increases in risk premia, and a marked economic slowdown in developing Asia. In 2016 severely adverse scenario is characterized by a severe global recession accompanied by a period of heightened corporate financial stress and negative yields for short-term U.S. Treasury securities.

According to EBA (2014, 2016) the objective of the EU-wide stress test is to assess the resilience of banks in the EU to adverse economic developments, helping supervisors assess individual banks, contributing to understanding systemic risk in the EU and fostering market discipline. The 2014 stress test includes 123 banking groups across the EU and including Norway with a total of EUR 28,000BN of assets covering more than 70% of total EU banking assets. The 2016 sample was reduced to 55 EU banks. The EU-wide stress test is coordinated by the EBA across the EU. The proposed adverse scenario reflects the systemic risks representing threats to banking sector stability such as an increase in global bond yields, especially in

emerging market economies. Further deterioration of credit quality in countries with feeble demand, weak fundamentals and still vulnerable banking sectors. Stalling policy reforms jeopardizing confidence in the sustainability of public finances and the lack of necessary bank balance sheet repair to maintain affordable market funding.

2.2. EBA and FED Stress Test Results Comparison

In tables below, we analyze EU and US stress test results. The analysis is based on counts of entities whose CET1 ratio decreased under 8%, 6%, 5% and finally 0% threshold. We compare EU and US results separately.

Table 1 Stress Test Adverse Scenario Results

		2014			2016		
	CET1 Band	Total	Adverse	Adverse %	Total	Adverse	Adverse %
EU	< 8%	123	51	41%	51	9	18%
	< 6%	123	25	20%	51	1	2%
	< 5%	123	18	15%	51	1	2%
	< 0%	123	5	4%	51	1	2%
	Average	9.2%			10.7%		
	Median	8.2%			9.5%		

		2015			2016		
	CET1 Band	Total	Adverse	Adverse %	Total	Adverse	Adverse %
US	< 8%	31	12	39%	33	14	42%
	< 6%	31	1	3%	33	2	6%
	< 5%	31	0	0%	33	0	0%
	< 0%	31	0	0%	33	0	0%
	Average	9.2%			8.9%		
	Median	8.1%			8.3%		

Source: Author calculation according to EBA (2014, 2016) and FED (2014, 2016) data

The table above displays stress test results in two dimensions, adverse CET1 evolution between two stress test periods and comparison of EU and US banks which failed to meet CET1 ratio thresholds. Analyzing the simple average and median figures there has been a certain improvement in the case of EU where the median CET1 ratio in adverse scenario increased from 8.2% to 9.5%. In the US, the growth was just 0.2% while average figure decreased by 0.3%. In 2014 EU stress test 41% of the sample reported adverse CET1 ratio below 8%, and 20% even below 6%, with 5 banks reporting negative figures. In 2016, there has been a significant improvement where only 18 % of the sample experienced CET1 ratio drop below 8%. In the case of US stress test these figures remained almost unchanged showing approximately 40 % of institutions with adverse CET1 ratio lower than 8%, while no bank reported ratios below 5%.

2.3. Representative Sample of EU and US Banking Institutions and Data Definition

To analyze the stress test impact a representative sample of 24 banks was selected with the goal to cover as much variability as possible. Constructing the sample, we took into the consideration the scope of the analysis as well as restrictions in bank shares availability, where not all bank shares are publicly traded or the market liquidity is low. The selected sample is divided in two dimensions. At first, we divide banks according to its origin where in the EU we analyze 16 and in the US 8 institutions. Further on we split the sample by the results in 2014/2015 adverse stress scenario on “BAD” institutions where the adverse CET1 ratio < 8% and “GOOD” ones where the adverse CET1 ratio > 8%. The entire sample overview is summarized in Table2.

Table 2 Representative Sample of EU and US Banking Institutions

					2014/2015			2016			
	NAME	CODE	EU/US	COUNTRY	ASOF	ADVERSE	GOOD/BAD	ASOF	ADVERSE	GOOD/BAD	CHANGE
EU BAD	Erste Group Bank AG	EBKDY	EU	AUSTRIA	10.0%	7.6%	BAD	12.4%	8.2%	GOOD	YES
	Bank of Cyprus Public Company Limited	BOC.AT	EU	CYPRUS	7.3%	1.5%	BAD	n/a	n/a	n/a	n/a
	Piraeus Bank S.A.	TPEIR.AT	EU	GREECE	10.0%	4.4%	BAD	n/a	n/a	n/a	n/a
	Allied Irish Banks, p.l.c.	AIBSF	EU	IRELAND	14.6%	6.9%	BAD	15.9%	7.4%	BAD	NO
	Banco Comercial Português S.A.	BPCGF	EU	PORTUGAL	10.3%	3.0%	BAD	n/a	n/a	n/a	n/a
	LIBERBANK	LBK.MC	EU	SPAIN	7.8%	5.6%	BAD	n/a	n/a	n/a	n/a
	The Royal Bank of Scotland Group plc	RBS	EU	UK	8.6%	5.7%	BAD	15.5%	8.1%	GOOD	YES
	Barclays PLC	BCS	EU	UK	9.1%	7.1%	BAD	11.4%	7.3%	BAD	NO
EU GOOD	KBC Group NV	KBCSY	EU	BELGIUM	12.7%	8.3%	GOOD	15.2%	11.3%	GOOD	NO
	DANSKE BANK	DSN.BE	EU	DENMARK	13.7%	11.7%	GOOD	16.1%	14.0%	GOOD	NO
	Societe Generale Group	GLE.PA	EU	FRANCE	10.7%	8.1%	GOOD	11.4%	8.0%	GOOD	NO
	Deutsche Bank AG	DB	EU	GERMANY	13.4%	8.9%	GOOD	14.7%	9.9%	GOOD	NO
	OTP BANK	OTP.F	EU	HUNGARY	15.9%	11.9%	GOOD	13.4%	9.2%	GOOD	NO
	Intesa Sanpaolo S.p.A.	ISP.MI	EU	ITALY	11.7%	8.3%	GOOD	13.0%	10.2%	GOOD	NO
	BANCO SANTANDER	SAN.MC	EU	SPAIN	10.4%	8.9%	GOOD	12.7%	8.7%	GOOD	NO
	HSBC Holdings plc	HSBC	EU	UK	10.8%	9.3%	GOOD	11.9%	8.8%	GOOD	NO
US BAD	The Goldman Sachs Group, Inc.	GS	USA	US	15.1%	5.8%	BAD	13.6%	8.4%	GOOD	YES
	Zions Bancorporation	ZION	USA	US	11.9%	6.0%	BAD	12.2%	6.6%	BAD	NO
	Morgan Stanley	MS	USA	US	15.2%	6.3%	BAD	16.4%	9.1%	GOOD	YES
	Citigroup Inc.	C	USA	US	15.1%	6.8%	BAD	15.3%	9.2%	GOOD	YES
US GOOD	Regions Financial Corporation	RF	USA	US	11.8%	8.5%	GOOD	10.9%	7.3%	BAD	YES
	Huntington Bancshares Incorporated	HBAN	USA	US	10.3%	8.7%	GOOD	9.8%	5.0%	BAD	YES
	American Express Company	AXP	USA	US	13.6%	13.0%	GOOD	12.4%	11.4%	GOOD	NO
	State Street Corporation	STT	USA	US	13.9%	8.1%	GOOD	13.0%	9.6%	GOOD	NO

Source: EBA (2014, 2016) and FED (2015, 2016) data

The daily share prices data was downloaded from finance.yahoo.com covering the period from 1.1.2012 to 10.1.2017. In the case of EU institutions, we are interested in share price reaction after stress test result announcement in October 2014 (26/10/2014) and July 2016 (29/07/2016) while in case of US institutions it is March 2015 (11/03/2015) and June 2016 (29.6.2016).

3. Stress Test Analysis Results

In the analytical part of the paper, we firstly perform correlation analysis to see dependencies between bank institutions within different economic environments, as well as we test correlations between "BAD" and "GOOD" performing banks. Further on we analyze the bank share volatility changes with the goal to assess immediate impact of results announcement on bank shares. At last we present results of AR(2) regression models where we are interested in long term impact, analyzing structural (dummy) variables significance and the direction of influence.

3.1. Correlation Analysis Results

Analyzing correlations between bank shares within the sample, we can observe strong positive correlations across the whole US sector, while the EU market is more heterogenous. Analysis shows also certain correlations between EU and US institutions, however the relationship is weaker then within EU and US sectors it selves. Certain positive correlations between banking institutions could have contributed to significant impact of 2016 results announcements, especially across the US banking sector.

Table 3 Correlation Analysis

		EU BAD								EU GOOD								US BAD				US GOOD			
		EBKDY	BOC.AT	TPEIR.AT	AIBSF	BPCGF	LBK.MC	RBS	BCS	KBCSY	DSN.BE	GLE.PA	DB	OTP.F	ISP.MI	SAN.MC	HSBC	GS	ZION	MS	C	RF	HBAN	AXP	STT
EU BAD	EBKDY	100%																							
	BOC.AT	22%	100%																						
	TPEIR.AT	44%	72%	100%																					
	AIBSF	-24%	-83%	-56%	100%																				
	BPCGF	18%	-27%	-2%	13%	100%																			
	LBK.MC	2%	-55%	-24%	55%	17%	100%																		
	RBS	19%	88%	65%	-86%	-31%	-38%	100%																	
	BCS	45%	86%	61%	-88%	-13%	-48%	86%	100%																
EU GOOD	KBCSY	15%	-10%	-22%	-6%	18%	32%	5%	-4%	100%															
	DSN.BE	-35%	-59%	-73%	42%	22%	39%	-46%	-58%	71%	100%														
	GLE.PA	43%	29%	22%	-45%	29%	15%	42%	41%	76%	26%	100%													
	DB	56%	86%	79%	-78%	-13%	-43%	80%	93%	-20%	-77%	33%	100%												
	OTP.F	-9%	-81%	-74%	76%	42%	40%	-87%	-70%	22%	64%	-13%	-75%	100%											
	ISP.MI	-16%	-8%	-40%	-12%	-11%	27%	16%	-2%	81%	73%	60%	-26%	10%	100%										
	SAN.MC	17%	85%	72%	-80%	-5%	-33%	87%	73%	16%	-34%	53%	71%	-74%	14%	100%									
	HSBC	42%	85%	81%	-80%	1%	-48%	78%	86%	-22%	-73%	27%	91%	-72%	-32%	80%	100%								
US BAD	GS	-11%	-1%	-27%	-22%	49%	0%	9%	10%	59%	55%	58%	-14%	24%	55%	23%	2%	100%							
	ZION	27%	-6%	2%	-6%	78%	-4%	-17%	6%	32%	23%	44%	-1%	37%	0%	10%	17%	69%	100%						
	MS	-13%	9%	-13%	-31%	43%	-3%	18%	12%	66%	54%	63%	-10%	10%	57%	38%	9%	94%	64%	100%					
	C	13%	31%	1%	-51%	37%	-23%	36%	47%	41%	18%	60%	25%	-3%	35%	43%	39%	86%	68%	82%	100%				
US GOOD	RF	22%	1%	12%	-13%	79%	2%	-6%	10%	35%	21%	50%	3%	25%	4%	24%	22%	70%	96%	69%	68%	100%			
	HBAN	-15%	-29%	-45%	6%	45%	26%	-15%	-19%	75%	78%	60%	-40%	44%	71%	0%	-32%	88%	60%	85%	65%	62%	100%		
	AXP	21%	80%	76%	-77%	6%	-34%	80%	69%	14%	-36%	50%	69%	-73%	4%	92%	78%	25%	23%	41%	46%	36%	4%	100%	
	STT	2%	34%	5%	-50%	33%	-29%	37%	39%	44%	21%	53%	19%	-8%	33%	50%	39%	83%	62%	88%	90%	64%	63%	53%	100%

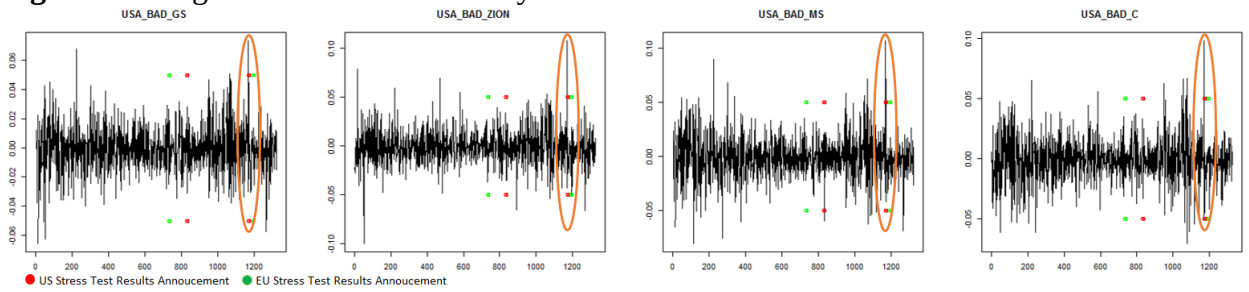
Source: Author calculation based on finance.yahoo.com data

Understanding correlations between institution shares within our sample is useful for further interpretations of the short term as well as the long term stress test impact within the volatility and regression analysis.

3.2. Volatility Analysis Results

Analyzing bank share volatility changes in the period around stress test results announcement, we can observe significantly higher volatility in 2016, specially across the whole US sector. On the one hand, this increased volatility proves that there is a significant, immediate impact of stress result announcement on bank shares. On the other hand, our assumption that institution whose CET1 ratio in stress decreased below 8% will experience drop in the share value was not confirmed. In contrary we can see a positive market reaction across the whole industry. In the case of EU 2014 and US 2015 stress test, there seems to be no or only limited volatility changes around observed period, which indicates no or only minor short term stress test impact.

Figure 1 Changes in Historical Volatility of Bank Shares



Source: Author calculation based on finance.yahoo.com data

Charts above show the historic volatility of selected bank institutions. The entire volatility analysis for whole sample can be found in Appendix 1. Analysis of volatility changes helped us to understand immediate, short term impact of stress results announcement on bank performance. To identify the long term, structural impact of stress tests we constructed the autoregressive

model with dummy variables representing stress test results announcement. From the analysis, it is also obvious, that the US results had quite significant impact on the EU institutions as well.

3.3. Regression Analysis Results

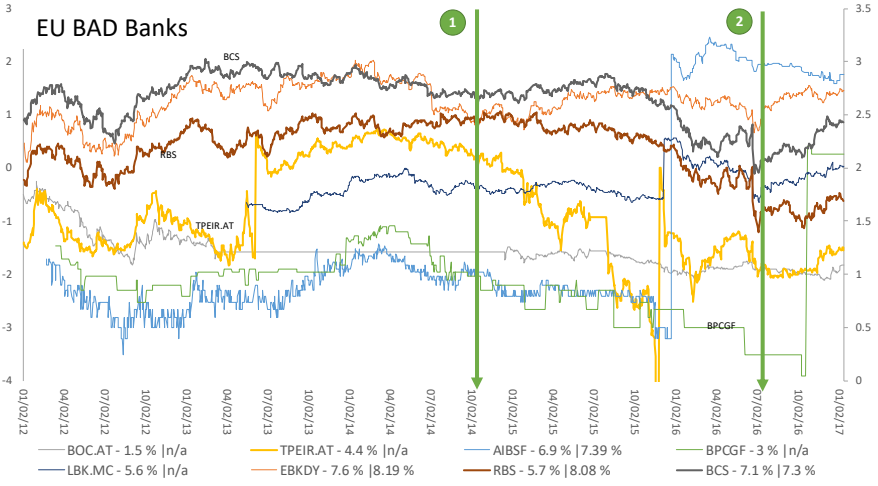
In following section, charts displays the evolution of share prices of EU and US banks, whereas tables contain results of AR (2) regression models where dummy variables EU_2014, EU_2016, US_2015 and US_2016 represents shocks caused by the stress test results announcement. In analysis, we are interested in the significance of dummy variable coefficients and its direction of influence.

3.3.1. EU and US "BAD" Institutions Results

Bad institutions are defined as the one, whose CET1 capital adequacy ratio in the adverse stress scenario decreased below 8%. For these institutions, we would expect that negative message about its capital situation will have a negative impact on share prices. Charts and tables below show the impact of two stress test shocks, the first in 2014 (US 2015) and second in 2016. Comparing adverse CET1 capital ratios between two periods, we can observe an improvement of capital adequacy in case of all EU and US banks within the sample. In the case of EU there are 4 banks, mainly from southern Europe which were not included in 2016 exercise.

Figure 1 and Figure 2 display the bank share prices time series as well as results of AR(2) model, where we focus on impact of stress test dummy variables on EU and US "BAD" banks.

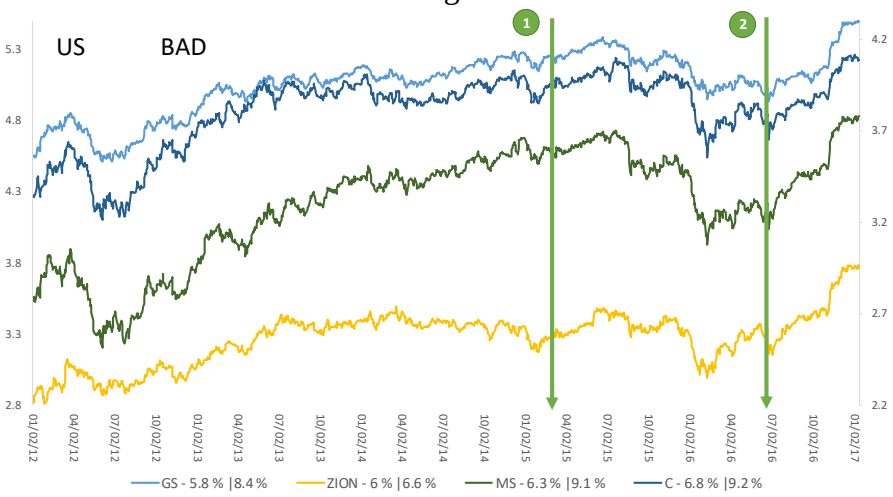
Figure 2 Share Prices Evolution in Time and Regression Results for EU BAD Banks



	Adverse CET1 2014 / 2016	(Intercept)	lag_1	lag_2	eu_2014	eu_2016
EBKDY	7.6 % - 8.19 %	** | +	** | +			
BOC.AT	1.5 % - n/a	** | +	** | +			
TPEIR.AT	4.4 % - n/a	** | +	** | +	* | -	** | -	
AIBSF	6.9 % - 7.39 %		** | +			
BPCGF	3.0 % - n/a		** | +			** | +
LBK.MC	5.6 % - n/a	** | +	** | +	* | -		
RBS	5.7 % - 8.08 %	** | +	** | +		* | -	
BCS	7.1 % - 7.3 %	** | +	** | +	** | -	* | -	
*0.1 | **0.05 | + positive impact | - negative impact						

Source: Author calculation in R based on finance.yahoo.com data

Figure 3 Share Prices Evolution in Time and Regression Results for US BAD Banks



	Adverse CET1 2015 / 2016	(Intercept)	lag_1	lag_2	us_2015	us_20016
GS	5.8 % - 8.4 %		** | +			** | +
ZION	6 .0% - 6.6 %	** | +	** | +			** | +
MS	6.3 % - 9.1 %		** | +			** | +
C	6.8 % - 9.2 %	** | +	** | +			** | +
*0.1 | **0.05 | + positive impact | - negative impact						

Source: Author calculation in R based on finance.yahoo.com data

As already mentioned for "BAD" institutions we would expect a significant deterioration of share prices after the stress test results announcement. From figures above it is obvious, that in most cases, there seems to be only limited impact on bank shares where only 3 banks in Europe proved significant coefficients of the 2014 shock. Taking into an account results of the volatility analysis, the example of TPIER.AT, RBS and BCS, shows rather long term influence, which contributed to bank shares value deterioration. If we consider results of US 2015 exercise, it seems to have no significant impact at all.

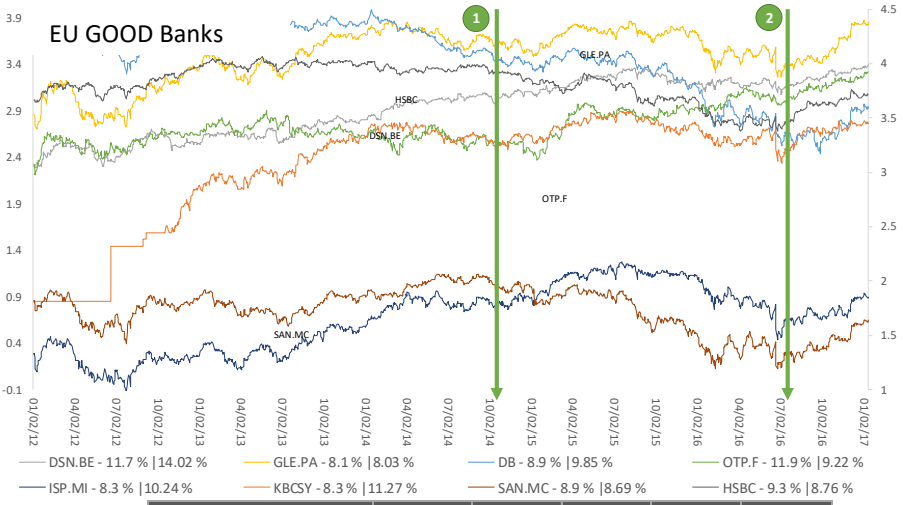
Having a look at 2016 results there seems to be a relatively strong positive impact of stress test results across the whole sector in US. This could be driven by the fact, that all institutions improved its capital situation as well as presence of the strong correlation between whole banking sector in the US. The EU 2016 stress test seems to be insignificant with only exception of BPCGF bank. Similarly, to volatility analysis, regression results also prove that there is a minimal sensitivity of markets towards the fact that banks CET1 ratio in adverse scenario decreased below psychological threshold of 8%.

3.3.2. EU and US "GOOD" Institutions Analysis

Conversly to BAD institutions a GOOD one are defined as those which CET1 capital adequacy ratio in adverse stress scenario remained over 8% threshold. For these institutions, we would expect that a good assessment of its capital position will have positive or at least not negative effect on share prices.

Figure 3 and figure 4 show the bank share prices time series as well as results of AR(2) model where we focus on impact of stress test dummy variables on EU and US "GOOD" banks.

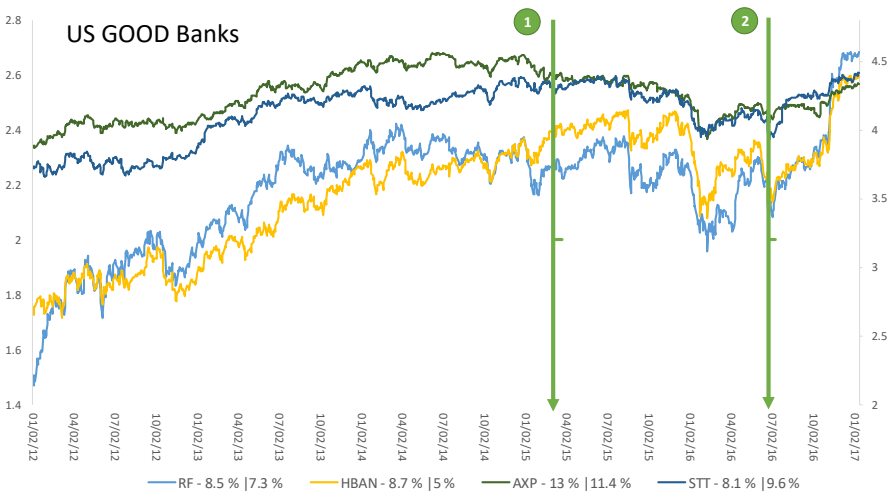
Figure 4 Share Prices Evolution in Time and Regression Results for EU GOOD Banks



	Adverse CET1 2014 / 2016	(Intercept)	lag_1	lag_2	eu_2014	eu_2016
KBCSY	8.3 % - 11.27 %	** | +	** | +			
DSN.BE	11.7 % - 14.02 %	** | +	** | +			* | +
GLE.PA	8.1 % - 8.03 %	** | +	** | +			* | +
DB	8.9 % - 9.85 %		** | +			
OTP.F	11.9 % - 9.22 %	** | +	** | +	** | +	** | +	** | +
ISP.MI	8.3 % - 10.24 %		** | +	** | +		
SAN.MC	8.9 % - 8.69 %	* | +	** | +		* | -	
HSBC	9.3 % - 8.76 %	** | +	** | +		** | -	
*0.1 | **0.05 | + positive impact | - negative impact						

Source: Author calculation in R based on finance.yahoo.com data

Figure 5 Share Prices Evolution in Time and Regression Results for US GOOD Banks



	Adverse CET1 2015 / 2016	(Intercept)	lag_1	lag_2	us_2015	us_20016
RF	8.5 % - 7.3 %	** | +	** | +			** | +
HBAN	8.7 % - 5 %		** | +			** | +
AXP	13 % - 11.4 %	** | +	** | +			* | +
STT	8.1 % - 9.6 %	** | +	** | +			** | +
*0.1 | **0.05 | + positive impact | - negative impact						

Source: Author calculation in R based on finance.yahoo.com data

Analyzing 2016 results there seems to be a relatively strong positive impact of stress test results across the whole US sector. In case of EU 2016 stress test there are banking institutions where the impact was positive. Contra-intuitive results can be observed in the EU 2014 case of HSBC and SAN.MC for which we identified significant negative impact despite the fact that its capital position in stress remained strong.

4. Discussion and conclusions

Banking in general can be considered as one of the fastest growing and most regulated industries. Under the pressure of last financial crisis, the entire banking system is undergoing major changes that require adequate and timely response from banking institutions as well as regulators. It should be the primary interest of banking institutions to maintain sound internal processes and try to predict and quickly react to sudden changes and threats from external environment. This should consequently help them to mitigate negative effects of economic cycles. The analysis of two different banking environments helped us to understand the impact of stress test result in slightly broader context, where we could observe certain correlations between EU and US institutions. From 2016 volatility analysis, it seems that US results had quite significant impact on EU institutions as well.

The analysis has proven that results of regulatory system wide stress tests have its importance and should not be underestimated. At the same time, it is important to realize that any model is just a simplification of the reality, and model results should be considered just like the general guideline and indication of further possible directions. Positive outcomes of 2016 stress test should not stop banking institutions from maintaining sound risk profiles, as well as strong capital structure, which are cornerstones of sustainable banking business and stability of entire financial sector.

For the further research in this area, it would be interesting to use more advanced approaches for the volatility analysis such as GARCH models, to detect the sudden change in variance of returns and the length of this variance shift and associate these changes with stress test results announcement shocks. Structural Vector Autoregressions (SVARs) models also provide an interesting approach for volatility changes identification, which is more calculation and methodology intensive. Moreover, it would be interesting to analyze changes in the banks' capital and Risk Weighted Assets structure after 2014 period and understand what was the banks' reaction concerning changes in the risk profile and balance sheet.

Adequate stress test framework should be an essential part of the sound and complex risk management strategy of each bank. The primary goal of this article was to analyze the impact of regulatory stress tests results on banking institutions as well as entire banking sector. The immediate, short term stress test impact was analyzed by changes in the bank's share price volatility around stress test results announcements. To identify potential long term influence we constructed a linear autoregressive model (AR2) with dummy variables representing stress test results announcement shocks. The outputs of both analyses indicate, that in the short, as well as long term horizon, stress test results had a certain significant effect on bank performance.

In case of FED US stress test, 2015 exercise seemed to have no, or only very limited influence. Significantly different situation was observed in 2016 where in all cases we identified relatively strong positive impact on the whole sector. In case of EBA EU stress test the conclusion is not so straightforward. The results are more heterogenous which can be driven by higher heterogeneity within EU banking sector proved by correlation analysis. In 2014 stress test three banks with insufficient capital in adverse scenario experienced negative impact of results announcement on its market value. At the same time, we could observe contra-intuitive results for HSBC and SAN.MC where we identified significant negative impact despite the fact that its capital position in stress remained strong. In EU 2016 stress test there are four banking institutions where impact was positive. Both volatility as well as regression analysis proved that there is only a minimal sensitivity of markets towards the fact that banks CET1 ratio in adverse scenario decreased below psychological threshold of 8%. Due to the certain correlations within banking sector, especially within US market, it seems that the stress test impact is primarily driven by results of the whole sector rather than individual institutions.

References

[1] ALTUNBASA, Y., GAMBACORTAB, L., MARQUES-IBANEZ, D. 2014. *Does Monetary Policy Affect Bank Risk?.* International Journal of Central Banking, volume 10 (No. 1), 95 - 135. Retrieved from http://www.ijcb.org/journal/ijcb14q1a3.pdf

[2] BOMFIM, A. 2003. *Pre-announcement effects, news effects, and volatility: Monetary policy and the stock market,* Journal of Banking & Finance, volume 27 (issue 1), 133–151. Retrieved from http://isiarticles.com/bundles/Article/pre/pdf/24857.pdf

[3] BORIO, C., GAMBACORTA, L., HOFMANN B. 2015. *The influence of monetary policy on bank profitability.* BIS Working paper No 514. Retrieved from http://www.bis.org/publ/work514.pdf

[4] FANELLI, P., BACCHIOCCHI, E. 2014. *Identification in Structural Vector Autoregressive models with structural changes, with an application to U.S. monetary policy*. Retrieved from https://www.nbp.pl/badania/konferencje/2014/im/pdf/BACCHIOCCHI_Emanuele.pdf

[5] LIA, H., LIUB, H., SIGANOSB, A., ZHOUC M. 2016. *Bank regulation, financial crisis, and the announcement effects of seasoned equity offerings of US commercial banks.* Journal of Financial Stability, volume 25, 37 – 46. Retrieved from http://www.sciencedirect.com/science/article/pii/S1572308916300493

[6] MISINA, M., TESSIER, D., DEY, S. 2006. *Stress Testing the Corporate Loans Portfolio of the Canadian Banking Sector*.
In Working Paper 2006-47 (ISSN 1192-5434). Retrieved from http://www.bankofcanada.ca/wp-content/uploads/2010/02/wp06-47.pdf

[7] VIROLAINEN, K. 2004. *Macro stress testing with a macroeconomic credit risk model for Finland.* Bank of Finland Discussion Paper No. 18/2004. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=622682

[8] WANG, P., MOORE, T. 2007. *Sudden changes in volatility: The case of five central European stock markets.* Retrieved from https://www.brunel.ac.uk/__data/assets/pdf_file/0020/84143/07-23.PDF

[9] Board of Governors of the Federal Reserve System. 2015, January 12. Dodd-Frank Act Stress Test 2015: Supervisory Stress Test Methodology and Results. Retrieved from http://www.federalreserve.gov/newsevents/press/bcreg/bcreg20150305a1.pdf

[10]Board of Governors of the Federal Reserve System. Press Release. 2015, January 17. Retrieved from https://www.federalreserve.gov/newsevents/press/bcreg/20150305a.htm

[11]Board of Governors of the Federal Reserve System. 2016, January 12. Dodd-Frank Act Stress Test 2016: Supervisory Stress Test Methodology and Results. Retrieved from https://www.federalreserve.gov/newsevents/press/bcreg /bcreg20160623a1.pdf

[12]Board of Governors of the Federal Reserve System. Press Release. 2016, January 17. Retrieved from https://www.federalreserve.gov/newsevents/press/bcreg/20150305a.htm

[13]European Banking Authority 2014, January 10. Results of 2014 EU-wide stress test. Retrieved from http://www.eba.europa.eu/documents/10180/851779/2014%20EU-wide%20ST-aggregate%20results.pdf

[14]European Banking Authority. 2014, January 15. EBA publishes 2014 EU-wide stress test results. Retrieved from http://www.eba.europa.eu/-/eba-publishes-2014-eu-wide-stress-test-results

[15]European Banking Authority 2016, January 10. 2016 EU-WIDE STRESS TEST RESULTS. Retrieved from http://www.eba.europa.eu/documents/10180/1532819/2016-EU-wide-stress-test-Results.pdf
[16]European Banking Authority. 2016, January 15. EBA publishes 2016 EU-wide stress test results. Retrieved from http://www.eba.europa.eu/-/eba-publishes-2016-eu-wide-stress-test-results

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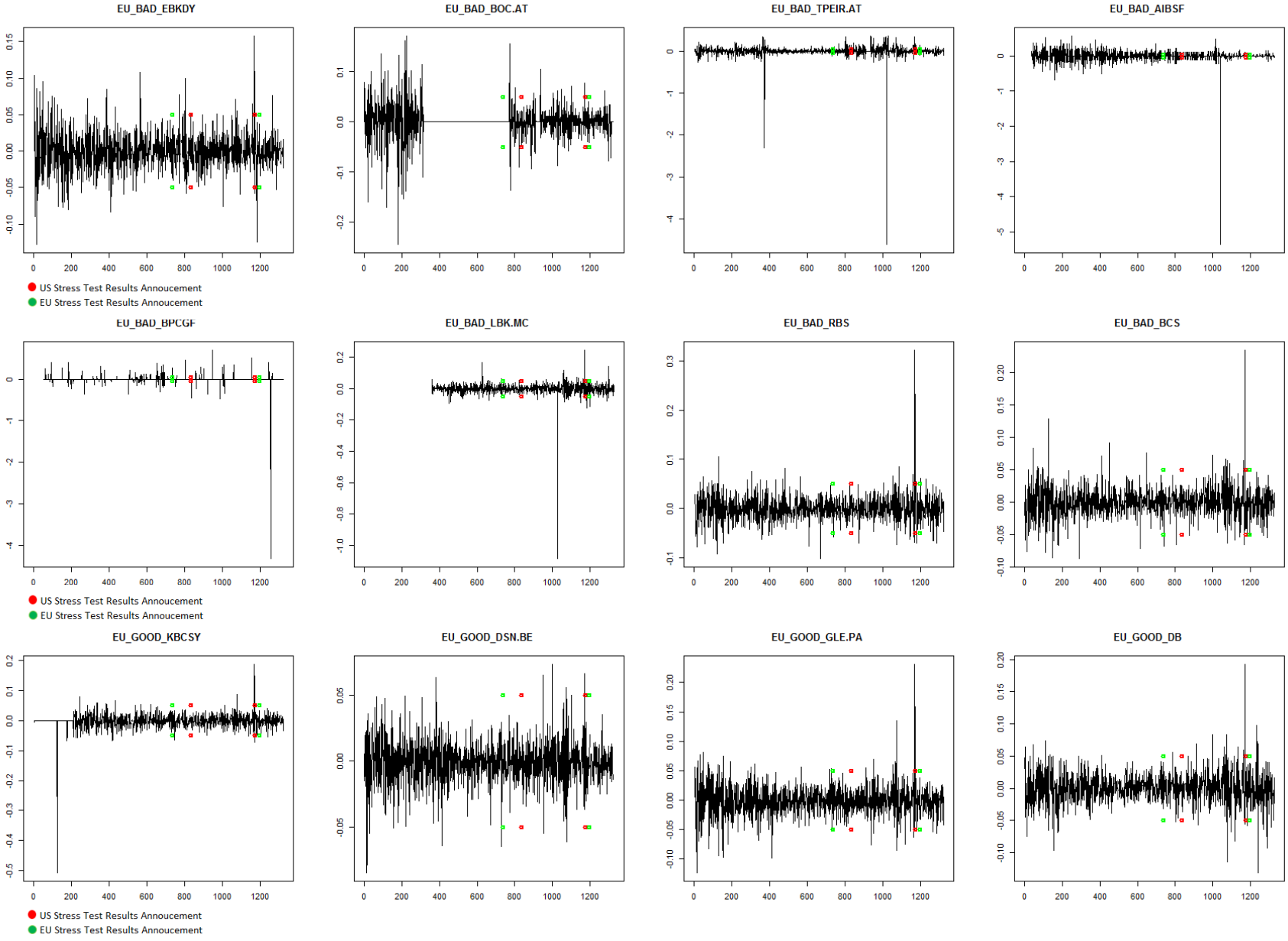
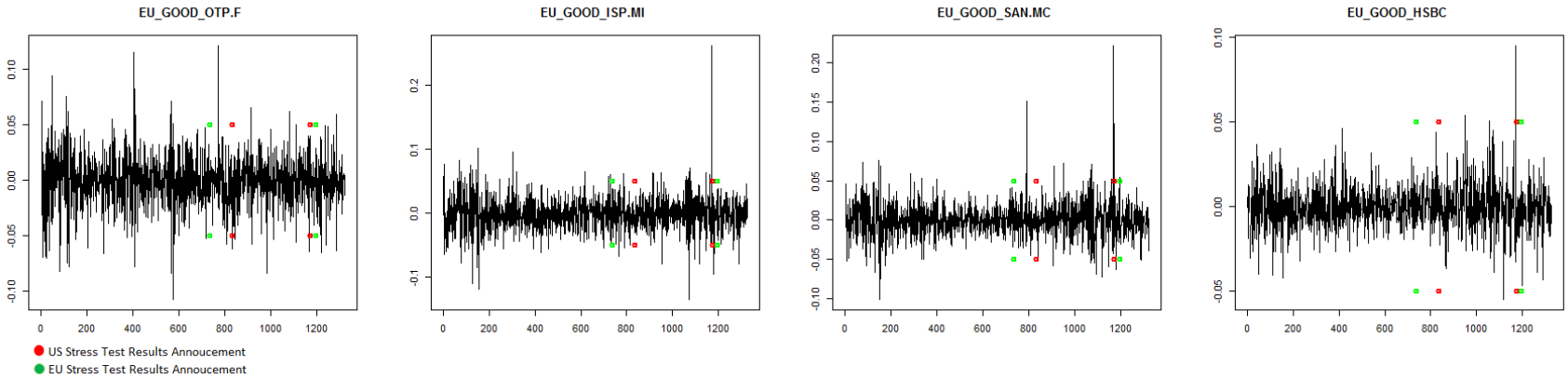
Appendix 1: Bank Shares Volatility analysis

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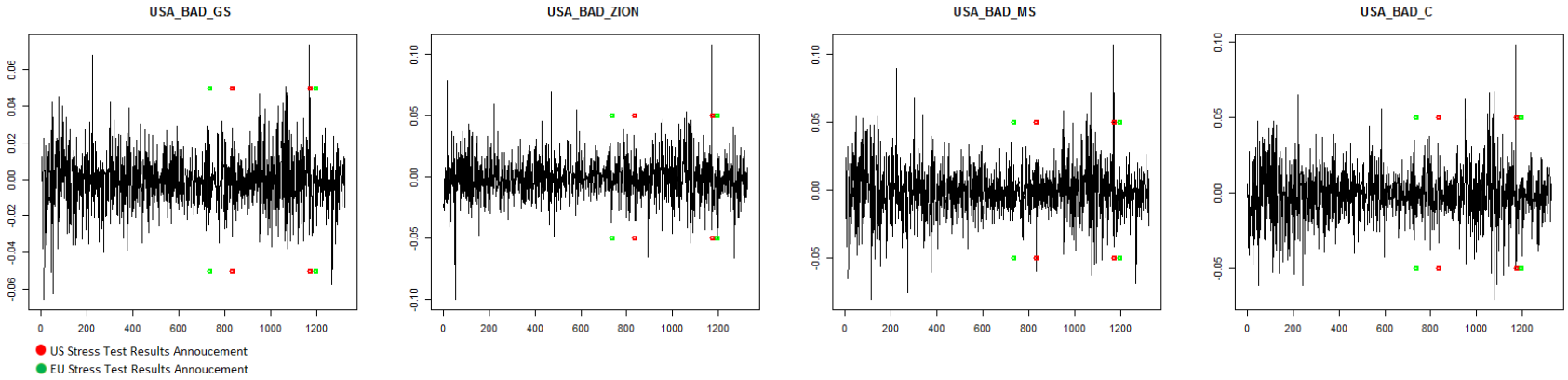
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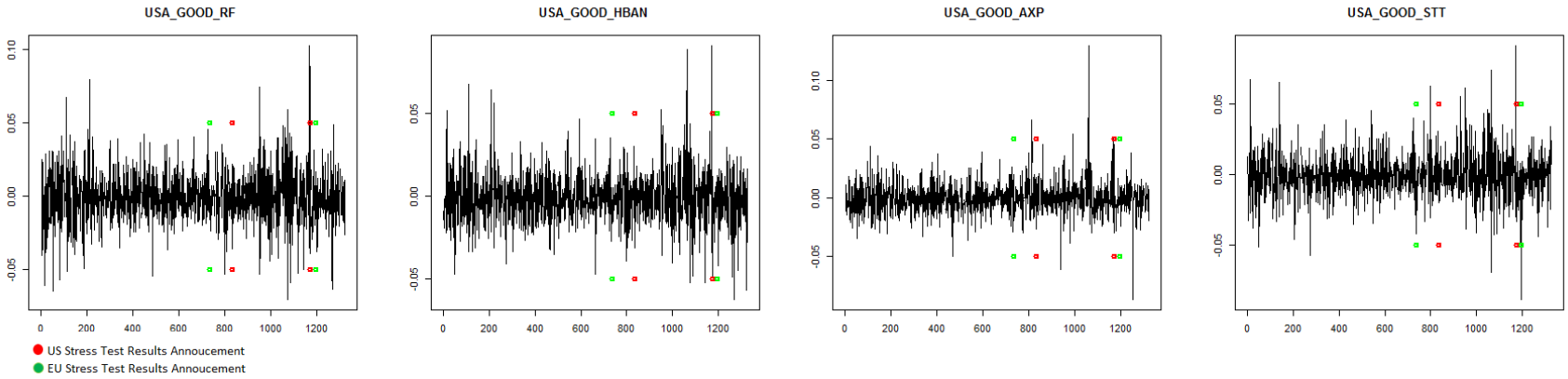
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EU Stress Test Results Annoucement